Global optimization software library for research and education

Nadia Udler

- Created for students and researchers
- Has its roots in potential theory
- Optimization methods with desired properties are created based on basic modules, by varying parameters of generalized algorithm
- Allows
  - to design optimization methods with guaranteed convergence but without the use of derivatives of objective function
  - to compare existing optimization methods
  - to understand principles of learning algorithms
  - to design custom variations or hybrids of known heuristic optimization methods.

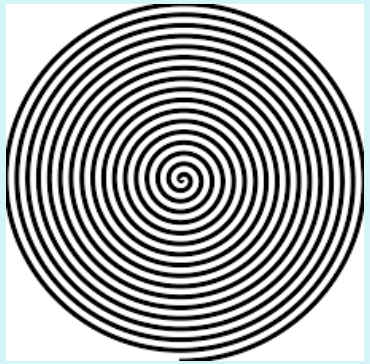
Selecting cleaning strategy

Example 1 : Vacuum cleaners

Goal: cover the entire surface

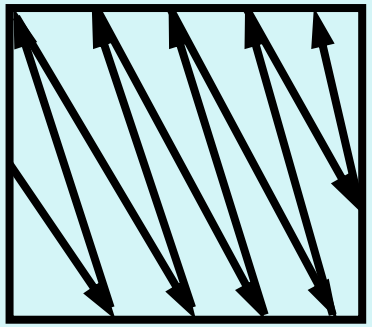
Possible strategies

Spiral-like motion from inside



Spiral-like motion from inside

90-degrees zigzag-like motion



30-degrees zigzag-like motion

Selecting cleaning strategy

Example 1 : Vacuum cleaners

Question: How to choose a strategy

Selecting cleaning strategy

Example 1 : Vacuum cleaners

Question: How to choose a strategy

Possible Answer:

1. Let user to navigate the vacuum cleaner

2. Have several buttons on the vacuum cleaner to let the user to switch between the strategies (automatic VC)

3. Let vacuum cleaner choose the best strategy (AI solution)

Selecting cleaning strategy

Example 1 : Vacuum cleaners

Do you have more questions

Selecting cleaning strategy

Example 1 : Vacuum cleaners

Question: what are important things to consider if the user has to come up with best strategy

1. **What is the goal**
2. **What are the constraints**
3. **What is the surface**
4. **……**

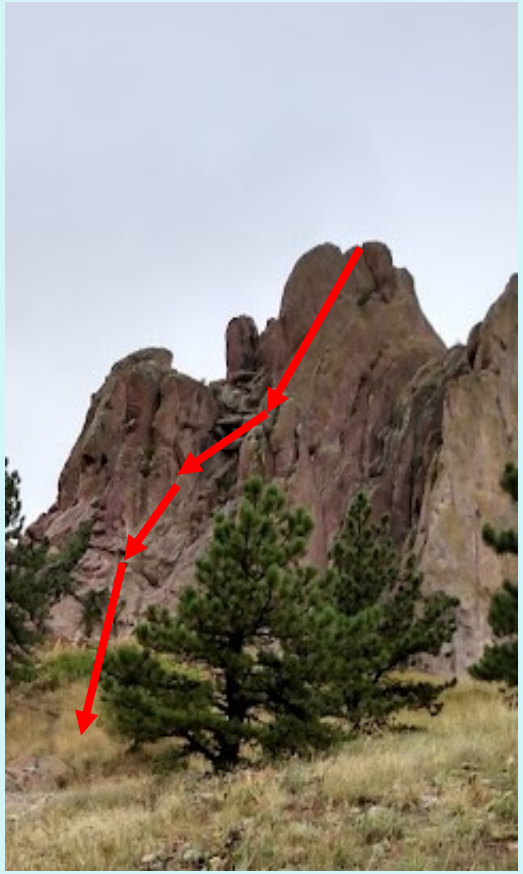
How easy is it to judge if selected strategy is the best? Or good enough? Or better than the other strategy? It would be nice to have a systematic approach to compare strategies!

Example 1 : Vacuum cleaners

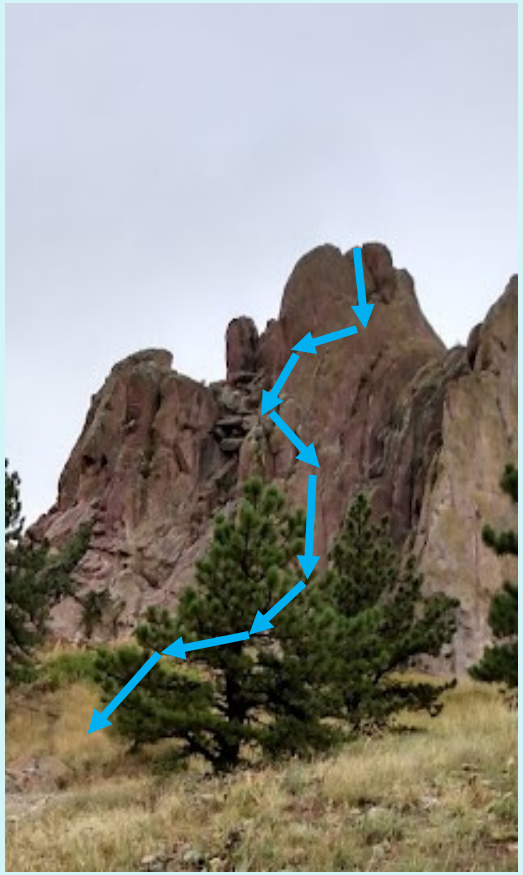
Questions about first example?

Selecting optimal path

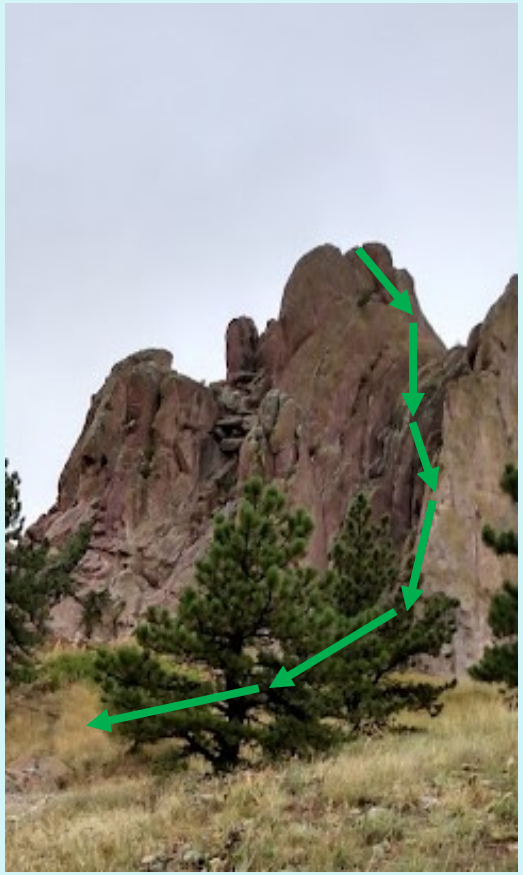
Example 2: find the best path down from the top of the mountain



Strategy 1



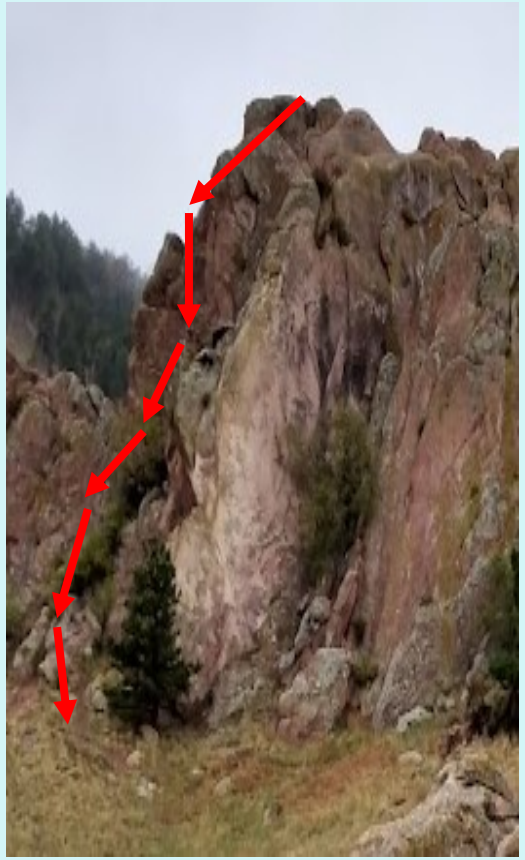
Strategy 2

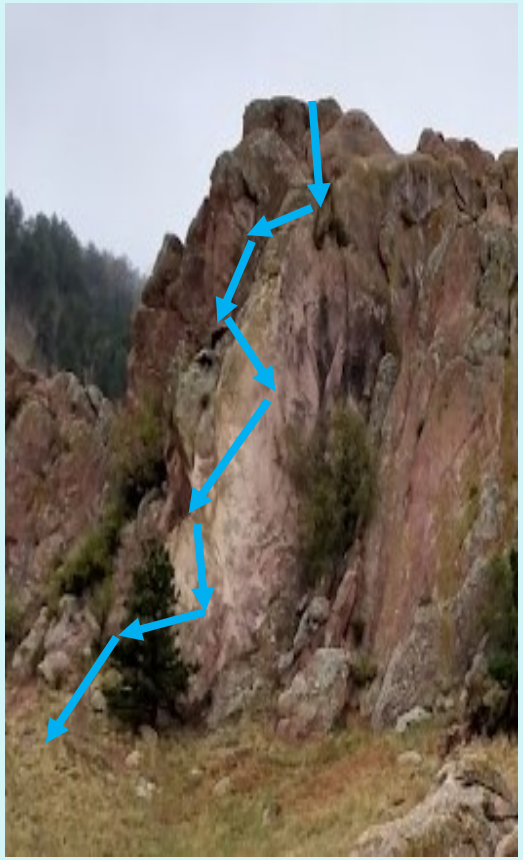


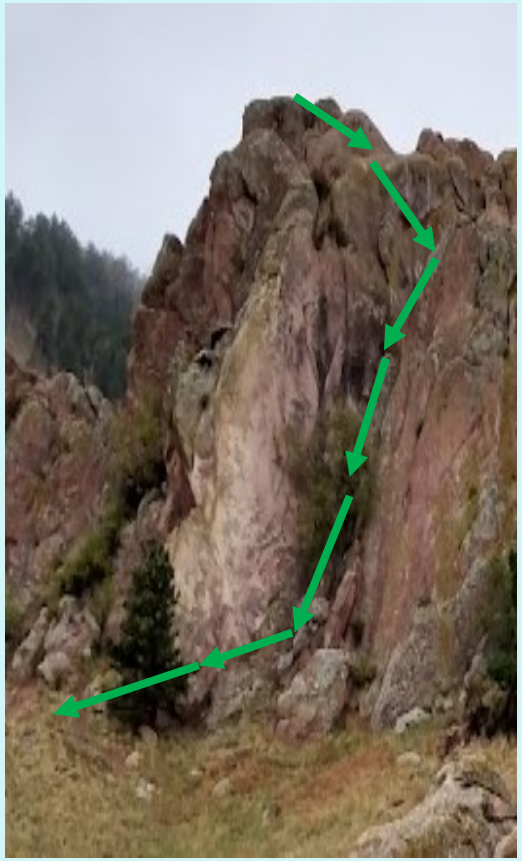
Strategy 3

Selecting optimal path

Example 2: find the best path down from the top of the mountain







Strategy 1 →

Strategy 2 →

Strategy 3 →

Selecting optimal path

Question: what are important things to consider if the user has to come up with best strategy to come down from the top of the mountain

1. **What is the goal**
2. **What are the constraints**
3. **What is the surface**
4. **……**

How easy is it to judge if selected strategy is the best? Or good enough? Or better than the other strategy? It would be nice to have a systematic approach to compare strategies!

Our software

why

1. It would be nice to have a systematic approach to compare strategies!
2. It would be nice to have a way to teach someone to apply and compare such strategies!

how

1. Our software is based on the systematic approach to construct global optimization methods (in other words, strategies)
2. Our software allows to construct your own strategy based on standard modules provided in the library

Next slides - More about our software

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Connecting Introductory example with general intent of our software

Optimization lies at the heart of machine learning and data science.
One of the most relevant problems in machine learning is automatic selection of optimization algorithm depending on the objective.
This is necessary in many applications such as robotics, simulating biological or chemical processes, trading strategies optimization, to name a few.

Connecting Introductory example with general intent of our software

Optimization methods in this library work with all objectives including very onerous ones, such as black box functions and functions given by computer code, and the convergence of methods is guaranteed.

Connecting Introductory example with general intent of our software

This library allows to create customized derivative free learning algorithms with desired properties by combining building blocks from this library or other Python libraries.